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Review Article

Tibial Tubercle Osteotomy for Patelofemoral Pain: A Systematic Review

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Abstract

Purpose: To perform a systematic review of clinical outcomes after TTO for patellofemoral pain due to chondromalacia or osteoarthritis in patients that did not respond to conservative.

Methods: A systematic review was designed following Preferred Reporting Items guidelines. We search the PubMed (Medline) database for all English-Spanish language between database inception and September 30, 2019. Inclusion criteria were Level I to IV studies on TTO for patellofemoral chondromalacia or osteoarthritis, which report clinical outcomes with follow-ups longer than one year. Exclusion criteria were non-English or Spanish studies, unpublished studies, Level V studies, basic science studies, letter to editors, articles without clinical outcomes and articles including patients with a history of patellar instability. All abstracts were reviewed separately by two authors. The quality of the studies was assessed using the modified Coleman methodology score. The success was defined by the proportion of patients achieving good or excellent results in the functional scale used by each article. We report the weighted mean of success (good-excellent results) overall and by diagnosis, type of osteotomy and in those studies that used Kujala score.

Results: A total of 14 studies were included. These studies were published between 1980 and 2017. There were 13 (93%) Level 4 and 1 Level 3 (07%) studies. The weighted mean age was 35 years [IC 95%, 29-40]. The weighted mean follow-up was 82.6 months [IC 95%, 78.9-86.3]. The median Coleman score was 49 (range, 18-84). Only four studies (28.57%) reached >55 points. The weighted proportion of good or excellent results was 0.61 [IC 95%, 0.60-0.63]. Kujala score was reported in 7 studies (50%) accounting 347 knees. The weighted difference paired by each study of the Kujala score was 32.7 [IC 95%, 31.4-33.9].

Conclusions: Few patients fail to conservative treatment, and TTO remains a useful surgical option for these patients, as over 60% of them have good to excellent result. There is still lack of evidence of which are the best patients for this procedure, but there is a trend to better results in osteoarthritis and when the cartilage lesion is in the distal patellar pole or the lateral facet.

Keywords: Patellofemoral chondromalacia; Patellofemoral osteoarthritis; Patellofemoral pain; systematic review; Tibial tubercle osteotomy

Introduction

Patellofemoral (PF) problems can be divided into patella instability and PF osteoarthritis (AO) or Chondromalacia (CM). Tibial Tubercle Osteotomy (TTO) may be utilized in these two scenarios, either to improve stability or to unload the PF compartment [1]. The key symptom in PF AO or CM is pain while prolonged sitting, squatting or climbing stairs which develop in reduced sports activity and affecting the quality of life [2]. TTO is a surgical procedure that can be chosen in patients with PF AO/CM that did not respond to a well done conservative treatment [3]. The purpose of this study is to perform a systematic review of clinical outcomes after TTO for patellofemoral pain due to chondromalacia or osteoarthritis in patients that did not respond to conservative.

Methods

A systematic review was designed following PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. We search the PubMed (Medline) database for all English-Spanish language between database inception and September 30, 2019. The algorithm used for search was "((patellofemoral pain) AND (tibial tubercle osteotomy [Title]) NOT instability [Title] NOT wedge[Title]" and "((patellofemoral pain) AND (tibial tubercle osteotomy) NOT instability[Title] NOT wedge[Title]". Inclusion criteria were Level I to IV studies on TTO for patellofemoral chondromalacia or osteoarthritis, which

reported clinical outcomes with follow-ups longer than one year. Studies that reported on duplicate populations were included only with the most recently available clinical outcome. Exclusion criteria were non-English or Spanish studies, unpublished studies, Level V studies, basic science studies, letter to editors, articles without clinical outcomes and articles including patients with a history of patellar instability. All abstracts were reviewed separately by two authors and assessed accordion to the criteria defined previously (CI and MB). Then the same authors reviewed the full text separately, and then discuss together the eligibility according to the criteria specified before. The flow chart of articles selection was summarized in Figure 1. The articles included in this study were summarized in Table 1 [4-17]. The quality of the studies was assessed using the modified Coleman methodology score (MCMS) [18], which ranges from 0-100. A study is classified to be of poor quality if the score is 55 or less. We record the number of patients, the number of knees, sex proportion, mean age, diagnosis (PF AO, PF CM or both), type of TTO (anteriorization, medialization, distalization, custom or combination) functional score scale used, and the percentage of good and excellent results reported by the authors. We report categorical data as absolute frequency and percent, and continuous data as means and Standard Deviation (SD). The success was defined by the proportion of patients achieving good or excellent results in the functional scale used by each article. Also, the weighted mean of patient reported satisfaction was reported . We report the weighted mean of overall success and by diagnosis, type of osteotomy and in those studies that used Kujala score. All statistical analyses were performed using STATA v.15 software.

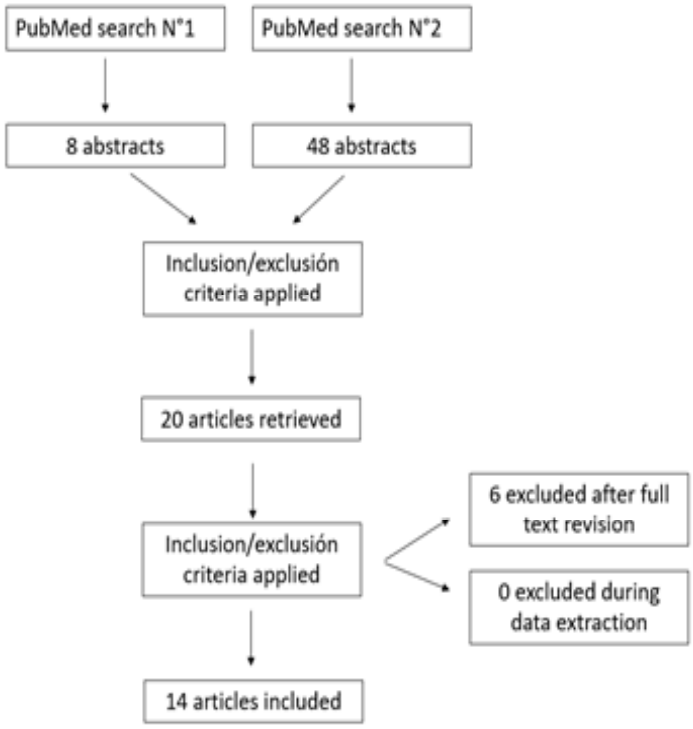

Figure 1: Flow chart.

Main Author	Diagnosis	Follow-up (months)	Number of knees/ patients Female proportion (Fp)	Mean Patient age	Type of TTO	Outcomes	Success/rate (SR) Patient satisfaction (PS)	Kujala
Kanazawa 2017	OA	90.1 (24-216)	Knees=37 Patients=31 Fp=0,73	57.6 (46-75)	AM	Kujala Fulkerson	Fulkerson>80% **SR = 0.81** **PS=NR**	Pre=34.1 Post= 80.8
Jack 2012	CM	72.4 (62-118)	Knees=50 Patients=47 Fp=0,83	34.4 (20-52)	AM	Kujala Pain VAS	Kujala >80% **SR=0.32** **PS=0.72**	Pre=39.2 Post=57.7
Koeter 2007	lateral tracking patela	24	Knees=30 Patients=30	26 (18-37)	M	Kujala	**NR**	Pre=62 Post=90
Al-Sayyad 2002	patela alta	29 (24-48)	Knees=29 Patients=25 Fp=0,45	35 (18-50)	D	Lysholm Kujala Pain VAS	Lysholm>0.8 **SR=0.89** **PS=0.88**	Pre=58 Post =83

Fisher 2016	CM	40.8 (24-88)	Knees=86 Patients=76 Fp=0.22	32.6 (21-49)	A + AM	Back to military training	Back to military training **SR=0,63** **PS=NR**	
Fulkerson 1990	CM	35 (26-50)	Knees=30 Patients=30 Fp=0,80	28 (14-56)	AM	Fulkerson	Fulkerson>80% **SR=0.89** **PS=0.93**	
Heatley 1984	a) OA b) CM	a) OA 72 b) CM 144	a) Knees=14 Patients=14 b) Knees=7 Patients=6	**NR**	A	Larson	Larson **a) SR=0.43** **PS= NR** **b) SR=0.83** **PS=NR**	
Jenny 1996	CM	132	Knee=65 Patients=65 Fp=0,46	43 (17-64)	A	Bandi Pain VAS	Bandi **SR=0.62** **PS=NR**	
Lui 2017	CM	55.2 (2.6)	Knees=61 Patients=57	29.6 (9.9)	AM	Kujala	**SR= NR** **PS=0.79**	Pre=51.2 Post=82.6
Maquet 1980	CM	29 (13-72)	Knees=9 Patients=8 Fp=0.5	NR	A	Bentley	Bentley **SR=0.75** **PS=NR**	
Rosso 2017	CM	67,9 (34.5)	Knees=78 Patients=69 Fp=0.74	43.5 (16.1)	AM	Kujala WOMAC	Kujala>80 **SR=0.39** **PS=0.68**	Pre=49.3 Post= 74.2
Schmid 1993	OA	192 (120-240)	Knees=35 Patients=30 Fp=0,31	34 (20-66)	A	Schmid	Schmid > 5pts **SR=0.8** **PS=NR**	
Valenzuela 2011	CM	162	Knees=28 Patients=28 Fp=0,46	43 (36-49)	A	Bandi	Bentley **SR=0.61** **PS=NR**	
Wang 2014	CM	120	Knees=62 Patients=56 Fp=0,74	45.7 (11.3)	AM	Kujala Lysholm	**SR=NR** **PS=0.79**	Pre=34.7 Post= 87.4

Fp=Female Proportion; NR= Not reported; CM= Chrondromalacia; OA= Osteoarthritis; VAS= Visual analogue scale; SR= Succesful rate according to the principal outcome of each study; Pre= Before surgery; Post= After Surgery at last follow-up

Table 1: Summarize all studies included in this study.

Results

A total of 14 studies, 621 knees and 572 patients were included. These studies were published between 1980 and 2017. There were 13 (93%) Level 4 and 1 Level 3 (07%) studies. Only 12 studies [4,5,8-17], 569 patients reported the mean age of the patients; the weighted mean age was 37.9 years [IC 95%, 37.2-38.6]. Eleven studies [4,5,7-11,14-17] reported the patient's gender, 262 female and 203 men were included, the weighted proportion of female was 56% [IC 95%, 54%-58%] and men was 44% [IC 95%, 42%-46%]. The weighted mean follows up was 82.6 months [IC 95%, 78.9- 86.3]. The median Coleman score was 49 (range, 18-84). Only four studies (28.57%) [8,10,12,15] reached more than 55 points. Kujala was the most used objective functional scale used, accounting for seven studies (50%). Others functional outcomes used were Bentley scale in two studies [7,16], and back to military training [9], Fulkerson [7], Bandi [10], Larson [6], Schmid [15] in one study. Only 11 studies [4-11,14-16] reported their success according to the objective scale. Six studies reported the patient satisfaction with the procedure [4,7,8,13,14,17].

The weighted proportion of success was 0.61 [IC 95%, 0.60-0.63] and the patient's satisfaction was 0.77 [IC 95%, 0.76-0.78]. Those patients with chondromalacia (n=476, 10 studies) achieved a weighted proportion of good or excellent results of 0.56 [IC 95%, 0.54-0.58] and the patient's satisfaction was 0.76 [IC 95%, 0.75-0.77]; meanwhile those patients with osteoarthritis (n=86 knees, 3 studies) achieved a weighted proportion of good of excellent results of 0.74 [IC 95%, 0.71-0.77]. Five studies (35%) [6,7,10,15,16] performed an anteriorization TTO, six studies (42%) [4,7,8,13,14,17] perform an anteromedialization TTO, one study (7.14%) [9] perform both anteriorization and anteromedialization, one study (7.14%) [12] a medialization TTO, and one study (7.14%) [4] a distalization TTO. The weighted success in anteriorization TTO (158 knees) was 0.66 [IC 95%, 0.64-0.68] and 0.53 [IC 95%, 0.50-0.56] in anteromedialization TTO (318 knees). Kujala score was reported in 7 studies (50%) [4,8,11-14,17] accounting 347 knees. The weighted mean Kujala score before and after surgery was 45.8 [IC 95%, 44.8-46.7] and 78.5 [IC 95%, 77.4-79.5] respectively. The weighted difference paired by each study of the Kujala score was 32.7 [IC 95%, 31.4-33.9].

Discussion

The first important founding of this review is that most of the studies included are only level 4 and only four of them are above the 55 points in MCMS, meaning that 11 studies are qualified as poor quality. Secondly, there is high variability in the type of TTO performed and on the scale used to evaluate functional results. PF pain is a challenging scenario for physicians. The keystone for treatment is to modified sports activity, correct muscular imbalance, physical therapy, to use anti-inflammatory drugs and loss weight [19]. Nevertheless, some patients will not respond despite complete adherence to conservative treatment. PF cartilage lesions have been targeted to be a cause of PF pain. Osteotomies around knee a well-known procedure to unload cartilage of a specific knee compartment alleviating pain and improve function [20]. TTO was first described in 1888 by Cesar Roux, after him, many authors have described their modification of the technique either to unload the PF or correct PF alignment [21]. Piodarano et al. described that better results are achieved when cartilage lesion is localized in the distal patellar pole or the lateral facet [3]. Recently this Piodarano, et al. [3]. series of cases were reevaluated in 2019, resulting in a 97% of the patient willing to have the operation if they have to; nevertheless, only 47% was performing mid to high sports activity and no functional scale was applied [22]. The latter being the reason to not include this work in this revision.

This study shows a weighted proportion of 0,66 of the patients achieving good to excellent results at a weighted follow up of four years seven month. Better results are expected if the patient's diagnosis is PF AO compared to CM. Patient selection is critical to achieving good outcomes. Paradoxically, many of the worst AKP cases are iatrogenic, resulting from surgery to address PF CM [23]. Due to the existing low-quality evidence, not a strong recommendation could be made in terms of specific patient selection, the indication still rale in a case by case decision. Most recent studies included in this systematic review use Kujala score to evaluate this results [4,8,11-14]. Kujala score was first described in 1993 [24] and then validated for asses clinical function in patients with anterior knee patient [25,26]. Also, have the advantage of been validated in different languages [27,28]. We strongly recommend that further studies to evaluate treatments outcomes for patients with anterior knee pain or PF pain use Kujala score. The most important limitation of this study is the quality of the studies, mainly due to the variability of the type of evaluation and type of osteotomy. Nevertheless, OTT has stood the test of time and is still a useful surgical procedure in cases of reluctant PF pain; the key is still to choose the patient correctly [29].

Conclusion

PF pain is a challenging scenario. The gold standard for treatment is to ovoid PF overuse, change sports habits, loss weight, anti-inflammatory drugs and physical therapy. Nevertheless, some patients fail to conservative treatment, and TTO remains a useful surgical option for these patients, as over 60% of them have good to excellent result. There is still lack of evidence of which are the best patients for this procedure, but there is a trend to better results in patients with PF AO compared to CM, and when the cartilage lesion is in the distal patellar pole or the lateral facet.

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